

## Development and Demonstration of a 250-Kilopound-Force Hybrid Rocket Test-Bed

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Recent increased interest in hybrid propulsion technology has prompted the formulation of an industry-led consortium to design, fabricate, and test a 250-kilopound-force thrust hybrid rocket booster system at MSFC's East Test Area. Hybrid rocket motors combine an inert solid-fuel grain with a gaseous or liquid oxidizer in an effort to realize the benefits of both liquid and solid rocket motors.

The new program, the Hybrid Propulsion Demonstration Program, combines efforts from the Hybrid Technology Option Project, the Hybrid Propulsion Technology for Launch Vehicle Boosters program, and the redirected Solid Propulsion Integrity Program. Participants include MSFC, Lockheed Martin Astronautics, Thiokol Space Operations, United Technologies Chemical Systems Division, the Rocketdyne Division of Rockwell International, Allied Signal, Lockheed Martin Manned Space Systems, and Environmental Aeroscience.

Hybrid propulsion activities have been ongoing at MSFC for several years through testing of the 11- and 24-inch motor systems at test stand 500. These motors will continue to be utilized to evaluate critical technology issues, including combustion stability, fuel utilization and web retention, nozzle and insulation materials response, and

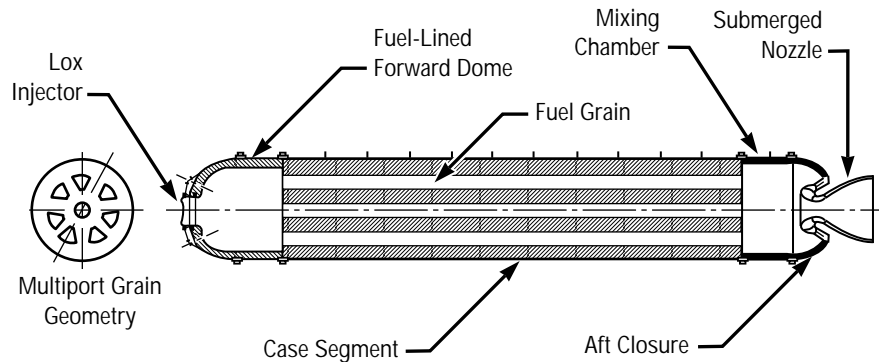


FIGURE 59.—250-kilopound-force hybrid motor design concept.

scale-up effects. Test results along with system studies will influence the large motor design. MSFC facilities, including feed, ignition, pressurization, and purge systems, will be expanded to support the testing of the 250-kilopound-force thrust motor system. MSFC science and engineering personnel will also provide for test and evaluation of the nozzle and insulation materials.

Hybrid propulsion is being considered for advanced launch vehicle applications due to advantages gained in safety, cost, environmentally benign combustion products, attractive performance, and mission flexibility relative to current rocket boosters. Recent advancements in the area of hybrid propulsion research have indicated potential application to both the expendable launch vehicle fleet and future launch vehicles. Figure 59 illustrates an early conceptual design for the 250-kilopound-force hybrid motor. The major case components include a domed forward closure, vaporization chamber, grain segment, mixing chamber, and aft closure. A submerged nozzle with exit cone is

planned, with initial test capability targeted for December 1996.

The goal of the program is to demonstrate critical hybrid propulsion technologies at the 250-kilopound-force thrust scale to minimize future full-scale development risk. Preliminary concepts of the booster show promise for application to both the X-33 Advanced Technology Demonstrator and the Atlas launch vehicle. Following completion of the X-33's technology demonstration phase, hybrid boosters are being considered to provide for commercialization and mission envelope expansion. Substitution of hybrid rocket boosters on the Atlas launch vehicle increase geosynchronous transfer orbit payload capability from approximately 8.1 to more than 10 kilopound mass in projected evolutionary schemes. Figure 60 illustrates a hybrid booster concept sized to support Lockheed Martin's X-33 Advanced Technology Demonstrator and the Atlas IIAH. Detailed cost studies and booster/launch vehicle trade studies will be performed to optimize these concepts.

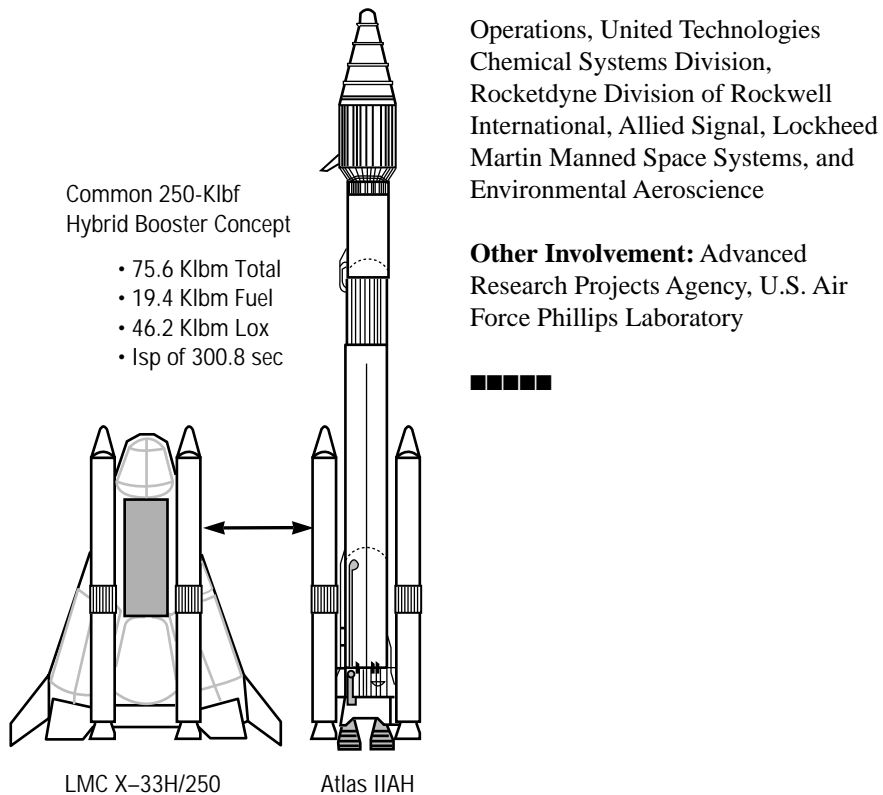


FIGURE 60.—Common hybrid booster concept.

Abel, T.M.; Carpenter, R.L.; Claflin, S.A.; Crawford, J.T.; and Holt, D.M. July 1995. Solid Rocket Motor Simulation and Hybrid Propulsion Testing at the Marshall Space Flight Center. Paper 95-2944, 31st American Institute of Aeronautics and Astronautics/American Society of Mechanical Engineers/Society of Automotive Engineers/American Society of Electrical Engineers Joint Propulsion Conference and Exhibit.

**Sponsor:** Office of Space Access and Technology

**Industry Involvement:** Lockheed Martin Astronautics, Thiokol Space